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Effects of high-level noise on the consumption of anesthetic agents during total intravenous anesthesia

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Abstract
Aim: The purpose of this study is to investigate the effects of high-level noise on propofol and remifentanyl consumption in patients who undergo cholecystectomy surgery under total intravenous anaesthesia (TIVA) during operation and on the satisfaction of patients and physicians.
Material and Methods: In this study, 90 patients who would undergo cholecystectomy surgery were randomized in 3 groups. It was planned as a double blind, prospective, randomized clinical trial. Propofol and remifentanyl infusion was started to obtain BIS values between 40-60 for all patients. The patients in Group N (n=30) were subjected to noise of normal operating room. The patients in Group S (n=30) were subjected to noise between 80-85 Db with headphone and for patients in Group Q subjection to noise of the operating room was prevented by covering the ears with headphones (n=30). Intraoperative total remifentanyl and propofol consumption of the patients, postoperative patient and physician satisfaction, postoperative side effects were recorded.
Results: Total remifentanyl and propofol used during surgery was significantly lower in Group Q than in Group N and Group S (p=0,0001, p=0,04). Postoperative patient satisfaction in Group Q was statistically higher than in Group N and Group S (p=0.001). Surgeon satisfaction in Group Q was also higher than in Group N and Group S (p=0.01).
Discussion: High noise level for patients who undergo cholecystectomy surgery under TIVA increases total remifentanyl and propofol consumption during operation. In addition, it decreases patient and surgeon satisfaction.

Keywords
Noise, Propofol Consumption, Remifentanil Consumption

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Introduction

Noise is defined as an unpleasant and unwanted sound. Environmental noise pollution is regarded as a general stressor, increasing mental stress, the development of cerebral cardio-vascular disease, and the risk of hearing loss [1]. Previous studies reported that the normal noise level in operating room was between 51- 79 dB and maximum noise level was between 80- 119 dB [1,2]. A quality improvement project underlined that noise can no longer be ignored as an unchangeable certainty in the operating room. Although patients were generally satisfied with their care, anesthetists perceived that excessive noise in the operating room negatively affected their ability to perform in the operating room. Noise is partly ingrained in operating room culture, but noise reduction can be achieved through training [3].

The role of music in the treatment of preoperative anxiety in adult patients was investigated. Researchers concluded that listening music before surgery had anxiolytic effects [4]. And in parallel with this, it was reported that music decreased sedative and analgesic requirements and reduced BIS score. Kühlmann et al. [5] reported that music provided a clinically meaningful reduction in pain and has been shown to reduce postoperative analgesic use. Capenetto et al. [6] stated that the most important effect of music applied to surgical patients is related to its positive effect on their psychological aspects. Ligree et al. [7] showed that noise-cancellation headphones can reduce anxiety and improve sedation scores.

But, in another study they reported that adding music during surgery does not provide any additional benefit when noise reduction technology is used. [8]. Therefore, we planned our study to make the answers of these questions clearer. In our study, we investigated the effect of noise on propofol and remifentanyl consumption and, anxiety in patients applied TIVA and sedation level in the patient and the surgeon during perioperative period.

Material and Methods

The study was conducted after obtaining the written informed consent from the patients. Ninety patients with ASA (American Society of Anesthesiologists) I-II whose ages were between 18-65 who would underwent cholecystectomy surgery under TIVA (Total Intravenous Anaesthesia) were included in the study. The study was planned as a randomized, double blind, prospective clinical study. Written consents of the patients were received after a detailed explanation was made on the previous day before the study, about anesthesia method to be performed. The work presented has been performed in accordance with the most recent version of the Helsinki Declaration.

The patients with midazolam or remifentanyl sensitivity, who had history of psychiatric drug usage recently, who had active respiratory tract infection and ear infection, who were addict of alcohol, narcotics or drugs, who had renal, cardiac or liver dysfunction, who were pregnant and did not want to be included to the study, were not included in the study. Audible level of the patients before surgery were tested audiometrically and the patients with auditory deficit were excluded from the study.

Preoperative sedation was not applied to any of the patients. Peripheral venous catheter was inserted, non-invasive blood pressure, peripheric oxygen saturation (SPO2), ECG (electrocardiogram) and BIS (Bispektral Index) were monitored after all the patients were entered in the operating room. Than demografhic values were evaluated with modified Observer's Assessment of Alertness/Sedation Score (OAA/S) 5 minutes before operation and at the 0th. minute. OAA/S: 0 = no response to painful stimulant; 1 = no response to delicate shaking and nudging; 2 = response only to delicate shaking and nudging; 3 = response only when called with noisy and repeatitive voice; 4 = lethargic response when called with normal voice; 5 = ready response when his/her name is called with normal voice [9]. Emergence agitation score (behaviour score) (1= sleeping, 2= awake, calm, 3= irritable, 4= inconsolable crying, 5= severe restlessness, disorientation) [10] and basal anxiety score were evaluated and also heart rate (HR) and mean arterial pressure (MAP) was recorded. The application of anesthesia was performed by a single assistant and the evaluation was performed by another individual blinded to the group of the patient. The patients were randomized according to the computer ranks.

The patients were intubated 2-4 minutes after anethesia induction was applied with standard doses of rocuronium bromide (Esmeron® vial 10 mg.ml-1, Organon, Oss, Holland) 0.5 mg/kg and propofol (Propofol 1% Fresenius®, 10 mg.ml-1, Fresenius Kabi AB, Uppsala, Sweden) 2-2.5 mg/kg, and they were connected to anesthesia machine. Maintenance of anesthesia was continued as TIVA by applying remifentanyl (Ultiva® 2 mg.ml-1, Glaxo Smith Kline, S.p.A, Italy) and propofol infusion with different perfusors (Braun Infusomat, Melsungen, Germany). Therefore, 0.01-0.1 µ/kg/min remifentanyl infusion and 6-10 mg/kg/hour propofol infusion were performed for BIS value to be in the range 40-60. Mechanical ventilation was performed with 50% O2 and 50% air. BIS measuring device (Aspect Medical Systems, Natick, MA) was used for monitorization. The patients were randomized into 3 groups according to the order in the computer. The patients in high noise group [Group S (n=30)] were subjected to noise in the environment together with induction (Noise of the alarm was increased, everybody spoke loudly, and music was listened to on the radio) and they were made to listen to traffic noise at the level of 80-85 dB with headphone. The sources of noise are different types of equipment; the conversations between the workers and the alarms of different equipment [11-13].

The ears were covered with headphones tightly in Group Q (silence group). Silence of the environment was maintained as far as possible. In the patient group where normal room noise was maintained [Group N (n=30)], the ears of the patients were left open so that they could be sensitive to the ambient noise. TIVA was terminated after surgical intervention was completed. HR, MAP, and BIS values were recorded during the intraoperative period at minutes 0, 5, 10, 15, 30, 45, and 60 and HR, MAP, sedation score and anxiety scores were recorded at minutes 0 and 5 after they were awakened. Postoperative total remifentanyl and propofol consumption of the patients; operation duration, recovery duration from anesthesia (time passed from extubation until verbal communication is established in postoperative observation room), patient and surgeon satisfaction scores (0= not satisfied, 1= slightly satisfied, 2= satisfied, 3= very

satisfied); side effects like postoperative nausea, vomiting, tachycardia, bradycardia (HR<50/dk), hypertension, hypotension (MAP<60 mmHg), coughing were also evaluated and recorded. Aneshesia and data collection were performed in each group by a person who had no information about the other group.

Statistical Analysis

SPSS (Statistical Package for Social Sciences) for Windows 16.0 statistics program was used in the assessment of the parameters studied. The demographic features of each group were compared by means of variance analysis. In order to analyze and compare the between-groups parametric data (comparison of MAP, HR, recovery time, duration of surgery, total remifentanil consumption and total propofol consumption) one-way ANOVA was used. The anxiety, sedation and satisfaction scores of the groups were compared by means of the Kruskal-Wallis test. The nausea-vomiting, bradycardia, tachycardia, hypertension, hypotension and coughing were compared with x2 test. All the data were expressed as mean ± standard deviation or percentage % or median (minimum-maximum). The statistical significance level was determined to be meaningful at p<0.05. We did not calculate the sample size. However, for purposes of the power calculation, a 25% increase in consumption of propofol and remifentanyl was considered to be significant.

Ethical Approval

This study was approved by the Ethics Commitee of Gaziantep University (Date: 2009-04-09, No: 2009/120)

Results

There was not any significant difference between the groups with regards to demographic data, recovery time from anesthesia and surgery (p>0.05) (Table 1). Total remifentanyl consumption determined during operation in Group Q was statistically significantly lower than Group N and Group S (p=0.0001) (Table 1). Total propofol consumption determined during operation in Group Q was statistically significantly lower than Group N and Group S (p=0.04) (Table 1). There was no statistical difference between groups with regard to preoperative and postoperative anxiety scores and sedation scores (p>0.05) (Table 2).

The postoperative patient satisfaction score in Group Q was statistically significantly higher than Group N and Group S (p=0.001) (Table 2). Postoperative surgeon satisfaction score in Group Q was statistically significantly higher than Group N and Group S (p=0.01) (Table 2).

A statistically significant difference was not observed with regards to postoperative complications like nausea, vomiting, hypertension, hypotension tachycardia, bradycardia and coughing (p>0.05) (Table 3).

Discussion

We investigated the effects of high-level noise in patients who underwent cholecystectomy surgery under TIVA on propofol and remifentanyl consumed during operation and postoperative anxiety and sedation levels. We observed that high-level noise increased the total propofol and remifentanyl consumed during operation. Besides, we determined that patient and surgeon satisfaction was significantly higher in the silence group.

Bispectral index (BIS) is a useful monitor for the evaluation of sedation, hypnosis and loss of consciousness and for the decrease of drug consumption, for the prevention of awareness

Table 1. Mographic data, recovery time, duration of surgery, total remifentanil consumption and total propofol consumption of the groups.

	Group S (n=30)	Group N (n=30)	Group Q (n=30)	p
Age (years)	44.1±15.4	40.8±13.11	45.8±13.7	>0.05
Weight (kg)	73.0±14.9	73.8±15.7	72.9±13.4	>0.05
Gender (M/F)	13/17	10.20	9.21	>0.05
Body Mass Index (BMI)	26.2±5.8	26.9±4.9	26.2±5.0	>0.05
ASA I/II	1.29	7.23	8/22	>0.05
Recovery time (minutes)	8.9±2.1	9.3±1.9	8.8±1.9	>0.05
Duration of surgery (minutes)	113.1±32.1	95.8±27.6	103.6±23.4	>0.05
Total Remifentanil Consumption (mg)	2.3±0.6	2.1±0.5	1.3±0.4*	0.0001
Total Propofol Consumption (mg)	855.0±310.0	743.1±181.2	690.4±267.1*	0.04

Values are represented as means ± SD
*p= 0.0001 when comparing Group Q with Group N and Group S

Table 2. The anxiety, sedation and the satisfaction scores of the groups.

	Group S (n=30) median (min-max)	Group N (n=30) median (min-max)	Group Q (n=30) median (min-max)	p
Preoperative Anxiety Score	3.0 (2.0-3.0)	2.0 (2.0-3.0)	2.0 (2.0-2.0)	>0.05
Postoperative Anxiety Score	2.0 (2.0-3.0)	2.0 (1.0-3.0)	2.0 (1.0-3.0)	>0.05
Preoperative Sedation Score	2.0 (2.0-3.0)	2.0 (2.0-3.0)	2.0 (2.0-3.0)	>0.05
Postoperative Sedation Score	2.0 (2.0-3.0)	2.0 (2.0-3.0)	2.0 (2.0-3.0)	>0.05
Postoperative Patients' Satisfaction Scores	2.0 (2.0-2.0)	2.0 (1.0-3.0)	2.0 (1.0-3.0)*	<0.05
Postoperative Surgeons' Satisfaction Scores	2.0 (2.0-3.0)	2.0 (2.0-3.0)	3.0 (1.0-3.0)*	<0.05

*p< 0.05 when comparing group Q with group S and group N.

and for providing short recovery periods [14, 15]. TIVA ensures fast induction, balanced maintenance of anaesthesia and also decreases side effects like nausea, vomiting, and shivering. The best combination in TIVA is generally obtained with remifentanyl and propofol which is hypnotic and analgesic [16].

Many studies performed before, showed that the noise level in the hospitals is far above the recommended noise level [6]. WHO (World Health Organisation) recommends a noise level of up to 30 dB in operating rooms but in reality, the noise level in operating rooms is higher than this value [2]. The studies performed before stated that the average noise level in operating rooms was between 51-79 dB and the maximum level was between 80-119 dB [2]. In our operating room the average noise is 65 dB. In our study, we used traffic noise between 80-85 dB together with ambient noise in the noise group both to generate adequate and not to cause damage to the patients .

It is known that audio warnings organize stress responses [17, 18]. In some studies, it was stated that music had reduction effect on stress during surgery and on anxiety before surgery [6]. But, different from this, noise may cause harmful hormonal changes associated with stress response and secondary effects such as hypertension on circulatory physiology [1]. Noise is also a stress source for employees and may disturb the concentration and the mental activity of the employees. It may impair the personal performance of the surgeon during the operation. Disturbance of mental activity is one of the most important reasons for medical error and side effects and this subject should be taken seriously [17]. In other words, noise may be a detrimental factor not only for the patients but also for the employees of the hospital. [19]. Noise causes physiological reactions such as increased blood pressure and long-term exposure can cause cardiovascular, metabolic and mental health disorders [20]. As noise is an important discomforting factor, healthcare workers should be protected from excessive noise.

At the end of our study, we determined that noise increased intraoperative propofol and remifentanyl consumption. In most studies performed with patients who underwent surgery under anesthesia, it was stated that music had effects in the direction that decreased the consumption of sedatives and analgesics [21-23]. Perioperative music may reduce the need for postoperative opioids and intraoperative sedative medications. Therefore, as higher opioid dosage is associated with an increased risk of side effects and chronic opioid use, perioperative music may potentially improve patient outcomes and reduce medical costs. Although no side effects were observed, the use of perioperative music appears to be safe and patient-friendly, given the reported high patient satisfaction [23]. Giordano et al. [24] reported that preoperative music therapy could be an alternative to intravenous midazolam when aiming to promote a preoperative and postoperative state of anxiolysis and sedation in stomatology surgery, even if no differences were found in terms of the surgery-related stress response according to physiological and hormonal determinations.

These studies suggest that while music is theoretically expected to decrease stress hormones in patients under general anaesthesia, noise might increase the consumption of sedatives and analgesics by increasing stress hormones. An increase in stress hormones related to noise may induce hypertension and this shall increase the requirement for propofol and remifentanyl. The increase in stress hormones might be a reason for anxiety in both the patients who recover from anaesthesia and the staffs working in the same environment. Surgeon satisfaction and postoperative patient satisfaction were the highest without noise pollution.

Table 3. The postoperative side effects of the groups.

	Group S (n=30) n (%)	Group N (n=30) n (%)	Group Q (n=30) n (%)
Nausea-Vomiting	5 (16.6%)	1 (3.3%)	4 (13.3)
Bradycardia (beat/min)	0 (0%)	1 (3.3%)	0 (0%)
Tachycardia (beat/min)	5 (16.6%)	9 (30%)	7 (23.3%)
Hypertension (mm Hg)	7 (23.3%)	0 (0%)	2 (6.6%)
Hypotension (mm Hg)	1 (3.3%)	0 (0%)	0 (0%)
Coughing	00 (0%)	7 (23.3%)	6 (20%)

n= 30, data was shown as n (%)
p> 0.05 when compared among the groups.

Conclusion

We observed that noise increased consumption of propofol and remifentanyl in patients who underwent cholecystectomy surgery under TIVA. The consumption was determined as a minimum in silence group. Furthemore, patient and surgeon satisfaction was also higher in the silence group.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or compareable ethical standards.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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